# Space Weather Technical Forecast

Issued on Saturday, 30 March 2024 at 01:23 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Further M-flares expected from AR3615 (R1-R2 Blackouts). Chance of X-flares (R3+ Blackouts). Activity easing Day 3 (01 Apr).**

**Analysis of Space Weather Activity over past 24 hour**

**Solar Activity:** Activity has been Moderate occasional M-flares, the greatest intensity peaking at M3.2 at 29/0230 UTC from AR3615. There are four sunspot regions on the visible disc, all of which are located in the western hemisphere. AR3615, approaching the southwestern limb, is a very large and magnetically complex region. Its location and restricted viewing angle reduces confidence in analysis. However, the trailing portion has continued to show development with well-defined delta-spot configurations.

Flare activity has produced a number of CMEs over the past 24 hours, however analysis would suggest that none of these are expected to be Earth-directed. A prominence eruption from the southeast limb was observed around 29/2100 UTC and is awaiting imagery for analysis. However, its location would imply that any ejecta would miss Earth.

**Solar Wind / Geomagnetic Activity:** The solar wind measured by ACE at L1 was indicative of ongoing ambient slow wind conditions. Winds speeds eased from slightly elevated, around 400km/s to background 340 km/s, with density below average throughout. Interplanetary Magnetic Field, Bt, was weak (below 5nT), with the North-south component, Bz weakly fluctuating between +2/-2nT. The phi angle was initially variable in direction, but since around 29/1230 UTC it has remained positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV) remained slightly above background, but well below the S1/Minor Radiation Storm level, and eased further through the day. High energy electron flux (greater than 2MeV) observed at GOES16 was mostly at background before rising to be largely Moderate since 29/1030 UTC. The associated 24-hour fluence remained below Active, with a value of 6.18e6 integrated pfu at 30/0000UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Moderate to High activity with further M-class flares expected, and a chance of isolated X-class flares from AR3615. This region is expected to depart the disc during Day 1 (30 Mar) with flare risks reducing significantly as the region becomes far-sided. However, any notable Strong flares may remain observable into Day 3 (01 Apr). No new or returning regions are expected to rotate onto the disc during the period.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs, although there is a slight chance that recent CME activity may produce a glancing blow during Day 1 (30 Mar). Background winds have the potential to become slightly enhanced Days 2-3 (31 Mar-01 Apr) from the arrival of coronal hole high speed streams. Mainly Quiet (Kp 0-2) geomagnetic activity forecast, with a chance of Unsettled (Kp 3) and a slight chance of Active (Kp 4) intervals with the onset of the faster solar winds or the arrival of a glancing CME blow.

**Energetic Particles / Solar Radiation:** High energy proton flux, as observed by GOES18, is

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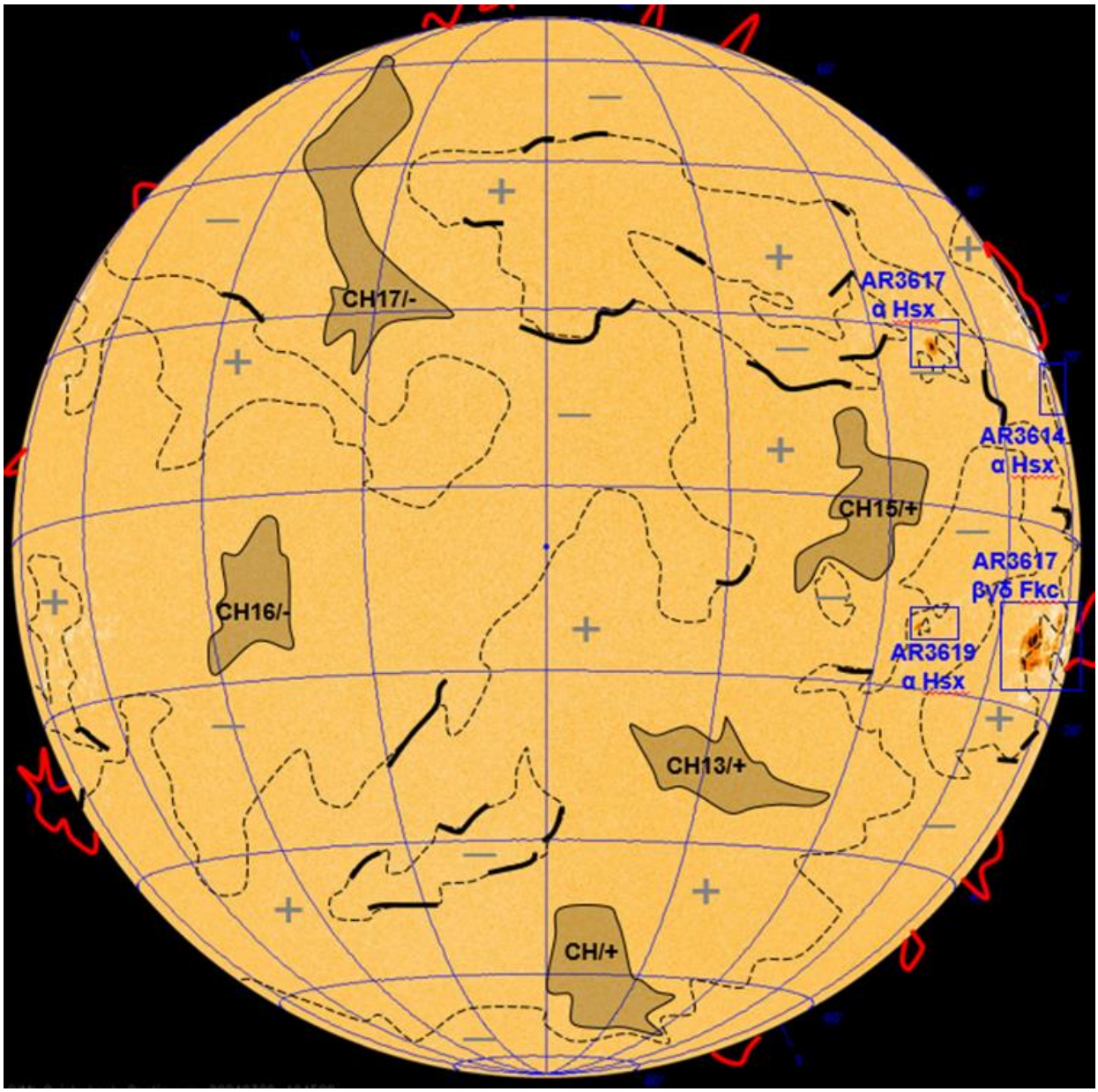
expected to continue easing to background in the absence of any notable flares from AR3615. There is a slight chance of a further enhancement above the S1 level given any strong flares from this region. High energy electrons are likely to continue at Low to Moderate levels, with only a slight chance of reaching High. The associated 24 hour fluence is expected to exhibit a slight increasing trend but remain well below the Active threshold.

**Figure 1. Solar Analysis Valid 29/2000UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are currently no Earth-directed CMEs expected during the forecast period. However, MOSWOC Enlil suggests that a number of recent CMEs that are projected to miss Earth may combine to give a glancing blow on Day 1 (30 Mar). This is currently considered low confidence.
Ambient slow wind conditions are expected through Day 1. A slight enhancement to speeds is likely Days 2-3 (31 Mar-01 Apr) due to the anticipated arrival of any fast wind associated with CH15/+ or CH13/+. These are small, non-recurrent features and are not favoured for connection at this time of year due to their positive polarity, as such, only a limited enhancement is expected. MOSWOC Enlil supports this slight increase.

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) during Day 1, but with a slight chance of an Active (Kp 4) interval should the glancing blow arrive at Earth. Chance of a spell of Unsettled to Active intervals (Kp 3-4) Day 2 (31 Mar), before easing through Day 3.

| Geo-Magnetic Storm<br>Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 5 | 1 | 1 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs currently expected.

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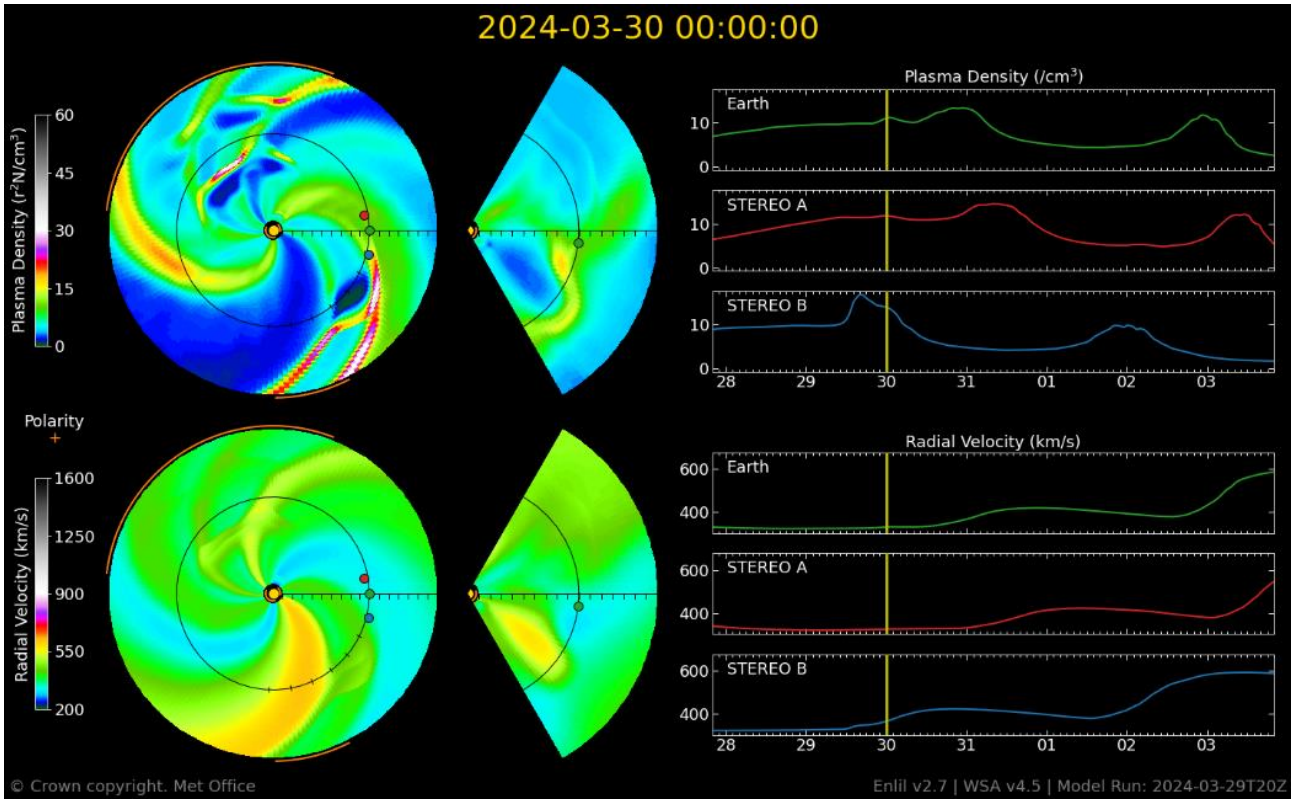
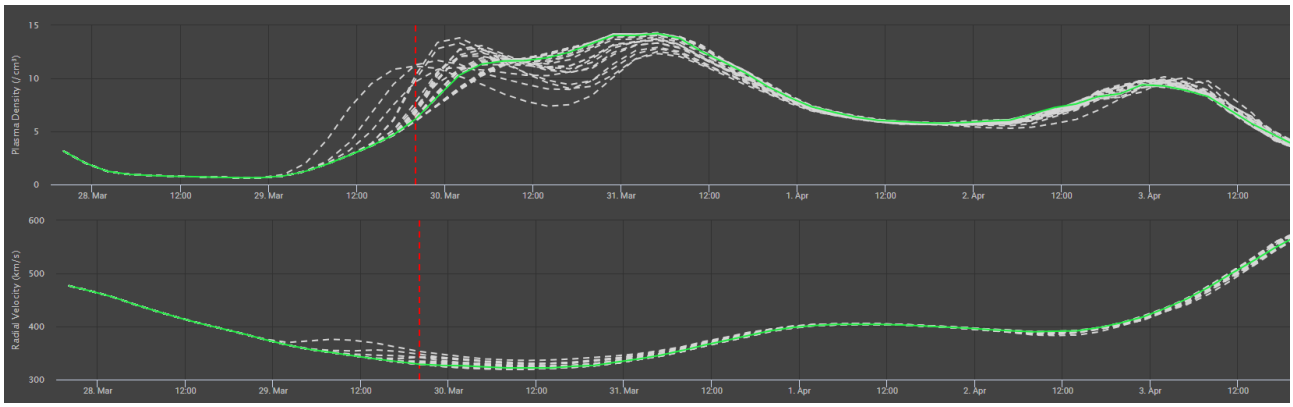
**Figure 2: MOSWOC Enlil and Ensembles showing potential glancing blow and slight HSS enhancement through period.**

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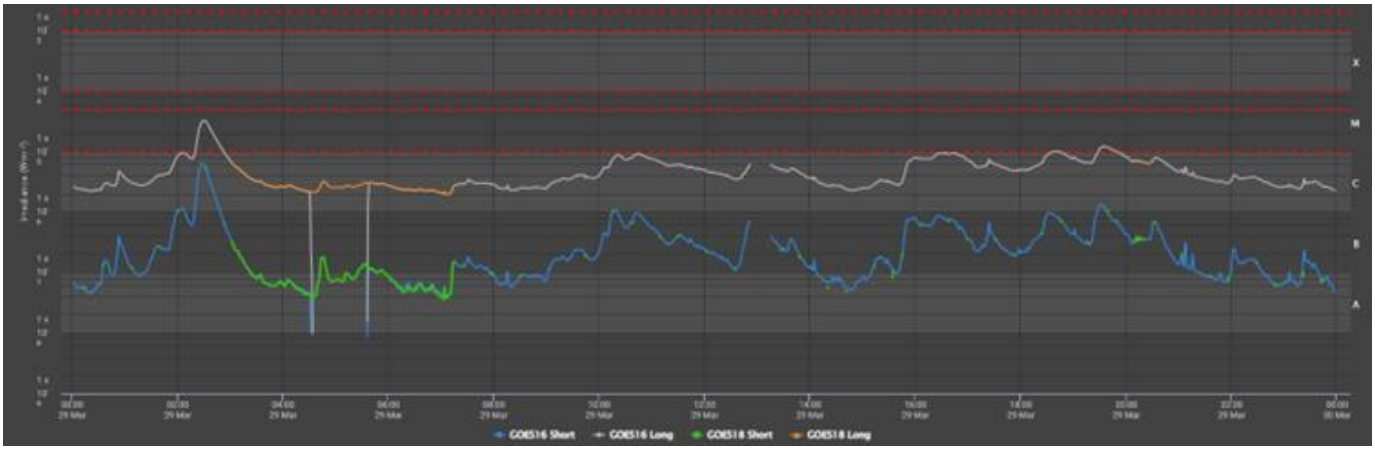
**Radio Blackouts - X-Ray Flares:**
Moderate to High activity is expected Day 1 (30 Mar) with further M-flares or an isolated X-flare possible from AR3615 as it continues to approach and cross the southwest limb. There is a very slight chance of an X10+ flare (R4 Blackout). Confidence decreases from Day 2 (31 Mar) as the region rotates away over the limb, but still with a risk of any large flares being observable. Activity likely eases to be Low by Day 3 (01 Apr).

AR3615 (Fkc/Beta-Gamma-Delta) dominates the flare forecast, as a very large and relatively complex spot. Dynamical evolution has been evident on the main trailing portion with the spot retaining a clear delta spot. This region has been responsible for the Moderate to Strong flares observed over recent days. There are three other small and simple sunspot regions on the disc, all in the western hemisphere, however these are mature and stable regions and unlikely to be sources of notable flare activity.

No new or returning regions are expected to rotate onto the disc during the period, with flare probabilities reflecting this.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 70 | 60 | 30 | 10 |
| Very Active | R3 to R5 X Class | No | 30 | 20 | 5 | 1 |

**Figure 3: GOES16 & GOES18 24 hour X-ray irradiance trace**

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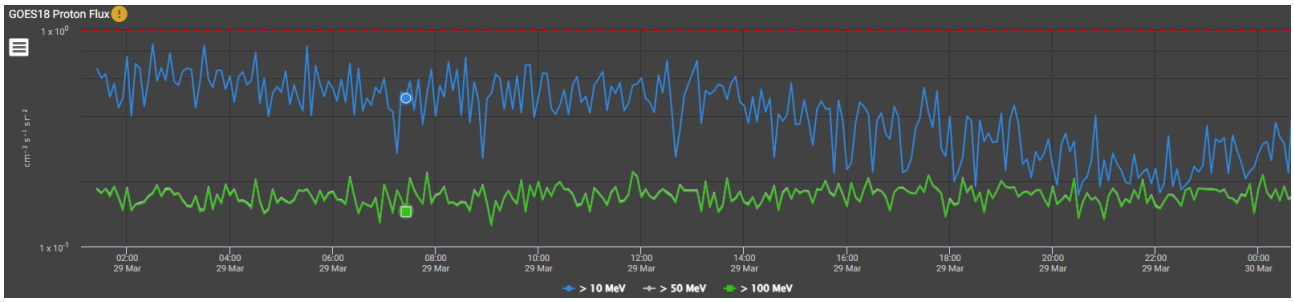
**Solar Radiation Storms - (High Energy Protons):**
High energy proton flux observed by GOES-18 remains slightly above background but well below the S1 Minor Radiation Storm level. This is due to the declining enhancement after the S2 Moderate Radiation storm that peaked 24 Mar. Further flares from the departing AR3615, especially more intense or longer duration ones, could still be eruptive and proton rich. The associated risk of proton events is maintained until the region has rotated fully beyond the west limb, declining by Day 4 (02 Apr).

There is a slight chance of reaching the S1/Minor Radiation Storm threshold, given any further significant flaring from this region.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 20 | 20 | 20 | 5 |
| **Very Active** | **≥ S3 *** | No | 5 | 5 | 5 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: GOES18 24 hour Proton trace**

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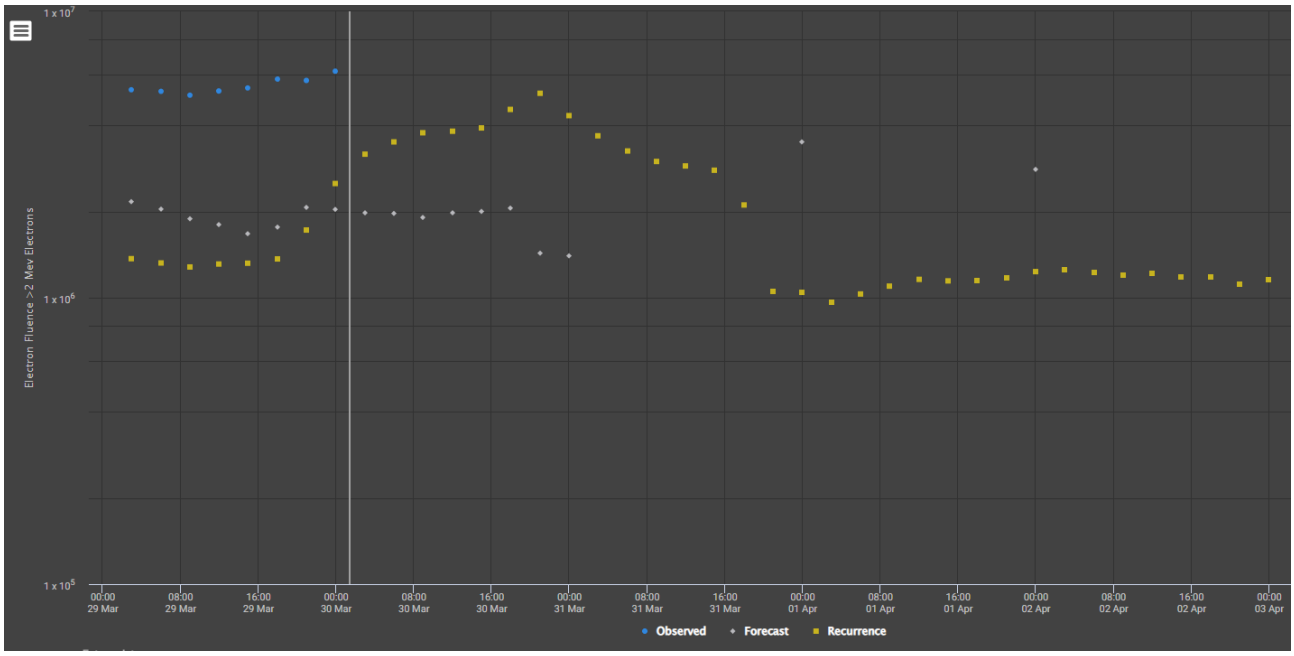
**High Energy Electrons Event (≥ 2MeV):**
High energy electron flux as observed by GOES-16 at GEO, has been Background to Moderate, with only a modest diurnal increase. This is despite the CME arrival last Sunday (24 Mar), which likely enhanced electron counts at lower orbitals. Although any associated enhancement at GEO now seems unlikely, there remains a chance of count rates giving brief periods of Moderate to High flux. Any fast wind connection to coronal holes CH15/+ and CH13/+ is expected to be minimal, and is not expected to increase the risk of prolonged High flux levels.

The associated 24 hour electron fluence is expected to remain well below the Active level, although a slight rising trend is possible during the period. Although fluence levels are currently above REFM forecast levels, REFM which is still considered to be giving good guidance for the trend of fluence values.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 1 | 1 | 1 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 5: MOSWOC REFM showing slight rising trend of fluence values.**

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